flame, with the result that in those series of experiments in which the height of the pentane air-gas flame was adjusted strictly according to the directions given in the Appendix, the light afforded by this flame was found to agree exactly with the mean result afforded by the standard candle flame. In other series of experiments, indeed, in which a slight variation was made in the mode of adjusting the height of the pentane air-gas flame, some discrepancies in the direct results furnished by the comparison of its light with that of the standard candle flame were observed; but in these several series of experiments also, when the necessary correction, called for by the difference in the mode of adjustment resorted to, was made, the light of the pentane air-gas flame was found to accord closely with the mean result afforded by the standard candle flame.

"(7) Inasmuch, however, as there is a practical advantage in comparing directly the light of such a coal-gas flame as is usually tested (being, that is, of about a sixteen-candle-light value), with a light approximating somewhat in value thereto, we have further submitted to careful examination the flame of the ten-candle-light pentane argand proposed as a standard by Mr. W. J. Dibdin in 1886. This flame is produced by burning a mixture of air and pentane vapour from a suitable argand burner, provided with an opaque screen by which the light from the upper portion of the flame is cut off. The screen being set at a definite height, it was found by Mr. Dibdin that, owing to a compensating action affecting the lower or exposed portion of the flame, the luminosity of this portion of the flame remains constant even under considerable variations, whether in the total height of the flame or in the proportion of pentane vapour to air in the mixture burnt. With a view to simplify the construction of the argand burner furnishing a cut-off flame of this constant luminosity, we have tried various changes in the form of the cone and in the division of the air supply to the flame, but in every case have found the original burner, as supplied by Mr. Sugg for the purpose, to give more satisfactory results than the modified forms.

"(8) The amount of light emitted by the portion of the Dibdin argand pentane-air flame that is used in photometry, being dependent on the distance above the steatite ring of a screen by which the upper part of the flame is cut off, we have come to the conclusion that when the bottom of the screen is fixed at a height of 2·15 inches (54·6 mm.) above the top of the steatite ring, the amount of light emitted by the lower portion of the flame is substantially equal to ten times the average light of a standard sperm candle flame, or to ten times the light of Mr. Harcourt's one-candle-light pentane air-gas flame.

"(9) We have further satisfied ourselves that any number of Dibdin argand burners may be produced, having the form and dimensions set forth in the Appendix; and that these several burners, when used in the manner there defined, may be depended on to furnish a flame giving, when duly screened on the top, ten times the average amount of light given by a standard sperm candle.

"(10) We therefore recommend that the pentane-air flame furnished by a Dibdin argand burner, having the form and dimensions set forth in the Appendix, and used in the manner there defined, be accepted as giving the light of ten standard candles, and that this flame be authorised and prescribed for official use in testing the illuminating power of the gas supplied by the London Gas Companies.

"(11) We further recommend that sealed specimens of the burner, the carburetter, and the pentane for use therewith, duly certified by the Gas Referees, be deposited with the Board of Trade, and also in such places and in the care of such persons as the Board may direct, to be available for the purpose of comparison, in the event of any question arising as to whether the pentane-air flame of some particular burner does or does not afford the same amount of light as that now proposed for adoption as a standard.

"(12) With a view to making some provision for future possible improvements and requirements, we further recommend that the Gas Referees be authorised, should they at any time see fit, to approve and certify for use in gas-testing any other flame based upon the 10-candle standard defined above, which they may consider suitable for the purpose, whether produced in a like or unlike way, and whether having the same or a different multiple value; such other flame, however, not to be used for gas-testing unless approved by the Board of Trade, and unless the Gas Companies give their consent to its adoption as a standard.

"(13) We further recommend that the illuminating power of coal gas shall continue to be recorded as heretofore in terms of the light given by a specified number of cubic feet (to wit, 5 cubic feet) burnt per hour from the standard London argand burner, but that, in testing the illuminating power of the gas, the requirement that the gas shall actually be consumed at this rate be rescinded, so as to allow the Gas Referees to sanction a mode of testing in which the gas shall be burned from the standard London argand burner at whatever rate is found requisite in order that it may give a light equal to that of the prescribed number of candles, and in which the illuminative value of the gas shall be calculated as being inversely as the rate at which such gas had to be burned during the testing so as to give this amount of light."

The Report is signed by Prof. William Odling, F.R.S. (Chairman), Mr. W. J. Dibdin, Dr. E. Frankland, F.R.S., Dr. A. Vernon Harcourt, F.R.S., Mr. George Livesey, Dr. William Pole, Mr. George Rose-Innes, Prof. A. W. Rücker, F.R.S., Dr. W. J. Russell, F.R.S., Mr. G. C. Trewby, and (subject to the omission from (13), line 7, of the words "the Gas Referees to sanction") by Mr. H. E. Jones. Prof. Vivian B. Lewes was the Secretary of the Committee.

SCIENTIFIC EDUCATION IN AMERICA.

UPON the occasion of the laying of the corner-stone of a new building for a Museum for Dartmouth College, Hanover, U.S., Prof. A. S. Bickmore recently delivered an address, in the course of which he dealt with the methods of scientific instruction in America. The College was originally designed to elevate the Indian race in America, hence its location at Hanover, New Hampshire, in 1770. It was named after Lord Dartmouth, who took a deep interest in the aborigines of the New World, and who was the principal benefactor of the school established for their education.

We extract the following from the report of Prof. Bickmore's address in the *New York Times*:—

"The present is pre-eminently an educational age, and the princely gift from one of our alma mater's loyal sons for the purpose of endowing a 'professorship of palæontology, archæology, ethnology, and kindred subjects, and for the erection of a building for preserving and exhibiting specimens illustrating the aforesaid branches,' is in perfect harmony with the judgment of the leading educators of our times, namely, that the greatest benefit it is our privilege to confer upon coming generations is to provide ever-increasing means for their mental improvement.

"As we meet to-day to lay the corner-stone of the noble edifice so generously provided for by the late Dr. Ralph Butterfield, and to celebrate the commencement of a structure which will add so largely to the educational facilities of this college, I invite you to consider with me, as a subject suggested by this occasion, 'The Place in Modern Education of the Natural Sciences and their Museums.'

"In a period which will ever be famous in history for the great donations that are being constantly made by our private citizens for the public good, it is worthy of our careful consideration that the most munificent gifts are almost exclusively for the purpose of promoting education. In the United States where even the existence of 'a Government for the people and by the people' must ever rest upon the intelligence and the integrity of each individual citizen, it is not a matter of desirability, but simply one of necessity, that the promotion of public instruction shall ever be a question of paramount importance.

AMERICAN SYSTEM OF TEACHING.

"Our American system of instruction may be rapidly summarised. First and lowest is the kindergarten, which may be regarded as still in its experimental stage, but which is certainly destined to become one of our most effective methods of mental training. Next come the public schools, supported by taxation, with their primary and grammar grades, and the high schools and private academies. Above these are the colleges, with their ever-increasing series of elective studies; and then the universities, with their special schools of science, medicine, law, and theology; and finally, the great post-graduate institutions, composed of entirely distinct corporations for the creation of great museums of science and art, and the accumulation of exhaustive libraries.

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"As nearly as it is possible to ascertain, we have been expending twice as much per individual for public education as England, but as she increases her grants for that purpose, our provision must be enlarged in the same ratio, and especially ought we to introduce the latest and most improved methods for imparting instruction.

"The National Educational Association, at its meeting at Saratoga in 1892, appointed a committee, with President Eliot at its head, to suggest improvements in the studies of our secondary schools, and in their report those educators state their opinion that 'the study of both plants and animals should begin in the lowest grade, or even in the kindergarten, and that such studies, with geography subsequently added, ought to count in an examination for college.' Indeed we find the latter study already in the curriculum of Harvard University. In 1882, just ten years before President Eliot's committee was appointed, we began to seek to render our Museum of Natural History in New York City an aid to the instruction given in our public schools, by placing in each of them a small cabinet of the rocks, corals, shells, insects, and birds of our own country, We also organised for the teachers a series of illustrated lectures, describing the collections on exhibition in our halls, and picturing the regions from which they came. Our first audience consisted of twenty-five teachers and three officers of our Board of Education. Last year, under the auspices of the State Superintendent of Public Instruction, we spoke directly at the museum, and indirectly by the repetition of our lectures elsewhere, to 103,000 of our educators and other citizens, and now, through a provision made by the last Legislature, our visual instruction will be repeated in the public schools of every city in our State, and in all the villages having a population of 5000 and upward, so that during the coming year we shall reach 800,000 pupils, besides large audiences of adults on the public holidays. The measure of success that has attended our labours has been largely due, first, to our belief that it is the duty and the privilege of every educational institution of every grade to try to render a distinct benefit to each class of the citizens, wherever it may be located, and, secondly, to the illustrative method employed based on the maxim that 'the eye is the royal avenue to the mind.'

"To the question, what kind of a collection in natural history should be desired for each of these grades of instruction, we would reply that it should exactly correspond to the curriculum of study adopted by that grade. A college museum should possess a full series of the animals, plants, and minerals of the State in which it is situated, with typical specimens of the orders of these natural kingdoms from other States and other Continents; and also a library that will enable its teachers to keep up with the general progress of their departments. Even this simple plan may be made to absorb more money than most of our colleges are likely to acquire for such purposes during many generations, on account of the unfortunate tendency in these times for many a friend of education to found a new institution which may bear his name.

"In this presence I hardly need to add that every student should be encouraged to improve his leisure hours in taking long walks through all the region surrounding his place of study, in order to make his own observations and his own deductions upon the physical geography and geology of the places visited. His vacations may in this way become quite as important as the same length of term time. If during these travels he will gather minerals, fossils, or make a small cabinet of botanical specimens or insects, he will not only gain important information, but will have discovered the true mode of gaining by healthy exercise in the open air that relaxation which is a necessary condition to the best results in the recitation room; and whatever may be his subsequent occupation, thankful indeed will he be that he commenced so early to learn how to forget the overwhelming cares of a busy life, and that therefore he is able once more to commune with nature as restfully as he did in his college days.

"A university which has courses of post-graduate studies added to its college curriculum may follow the same plan, and also provide the means for original research along those lines in which its professors may be eminent authorities. However, experience has taught us that when one enthusiastic instructor dies and another takes his place, the new occupant of the professorial chair usually has already given his leisure time to some one of the thousand groups of the animal kingdom entirely different from those studied by his predecessor, and the books and specimens he finds already gathered will prove of little value to him for the pursuit of his own favourite branch of our science.

MUSEUMS AS EDUCATORS.

"A museum of natural history developed by a distinct corporation may advance education in two different ways—firstly, by the exhibitions of its collections and by illustrated lectures; and, secondly, by securing such exhaustive series of specimens and the books treating of them as to render it possible for original research to be carried on in many or most of the orders of the animal kingdom. Such organisations could favourably utilise an unlimited amount of funds, and even partly to fulfil their mission must absorb enormous sums. They can, therefore, only be created in our great and wealthy cities, and in them only by a happy and enthusiastic co-operation of their State and Municipal Governments, supplemented by large gifts from their wealthiest and most generous citizens. Our museum in Central Park is becoming such an institution for instruction and investigation. The city has provided a site of eighteen acres and $2,500,000 for that part of the structure already erected and under contract. Our specimens and books, the gifts of private citizens, amount to about $2,000,000 more, and yet we have completed less than one-fifth of our proposed edifice. The Art Museum has even a larger property and as comprehensive a plan, and now the Lenox and Astor Libraries, and the Tilden gift are happily united, and together form a third stone in the arch of this central university for the highest culture. So that, while we visit London to admire its group of noble institutions at South Kensington, we are at the same time founding in our new land a similar series on a greater scale, and erecting buildings and accumulating collections at a rate not witnessed on the other side of the sea; but the extensive ground plan upon which we are building the Museum of Natural History embodies the views of the late Sir Richard Owen, the ablest investigator in our science of the present century.

"In such a museum the specimens of minerals, rocks, and even fossils may be nearly perfect in themselves or fairly representative of the formations from which they were taken, but it should be remembered that in the usual mode of exhibition of animals and plants we necessarily lose the charm of their environment. Thus the song-thrush, which in life fills these northern valleys with the magical music of its liquid notes, when mounted and placed in a case is not only mute but uninteresting. The humming birds, in all their array of brilliant gems, to be known must be seen alive, darting to and fro amid the fragrant and richly-coloured flowers which supply their food in the tropical lands where the stately palm-trees wave their graceful fronds. The albatross, as usually mounted, with its wings tamely folded, hardly suggests the noble bird that skims gleefully over the crests of mountainous waves, while the storms are raging in the 'Roaring Forties' of the southern ocean. The chamois can only be appreciated when it is seen aloft on some projecting crag of the Alps, and the Rocky Mountain goat when, after long climbing, we find it surrounded by the splintered peaks of the Selkirks high up on the borders of eternal ice.

"To remedy these defects such a progressive thinker as Sir William Flower wisely proposes an entire change in the present style of taxidermy, and our experience in New York has been that our cases of American birds in their native haunts are among the most attractive as well as instructive displays in our halls. In our illustrated lectures we exhibit on one screen the Rocky Mountain sheep, while we picture on another screen beside it the grand mountain of the Holy Cross, where this rare animal formerly roamed.

"Zoology has attained a prominent place in this country largely through that great investigator and instructor, Prof. Lewis Agassiz, whose marvellous store of knowledge was equalled only by his devotion to his favourite study.

"But while science should be pursued for science's sake, yet we must not under-estimate the value of the technical sciences which take the results of original research and transform them so that they may confer an immediate and practical benefit upon the whole world. It is in this great department of modern education—the applied sciences—that the American people are pre-eminently successful, and in the coming contest for the supremacy among all nations, ours is destined to maintain a commanding place through our untiring industry, inventive genius, and peculiar adaptability to meet new conditions."

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